

## **Lesson 4, Activity 3**

### **Microbe Multiplication Magic (45 minutes)**

#### **Section**

Diseases

#### **Investigative Questions**

How do environmental conditions affect the reproduction rate of bacteria? How can a change in these conditions affect the total number of bacteria?

#### **Description of Content**

In this activity, students will learn how rapidly *Escherichia coli* (*E. coli*) bacteria reproduce. They will also see how environmental conditions such as temperature can affect the reproduction rate of *E. coli*. They will figure out how they might disrupt the environment that allows *E. coli* to reproduce, thus reducing the spread of infection.

#### **Relevant Standards**

This activity fulfills [science and health education standards](#).

#### **Materials**

- Student Reproducible 1: *Microbe Multiplication Magic*

#### **Objectives**

Students will:

- Calculate and graph the growth of bacteria under different environmental conditions
- Explain the role of the environment in the spread of disease

#### **Safety**

Normal classroom safety procedures should be followed.

#### **Procedure**

*Engagement* (5 minutes)

1. Bacteria can divide very rapidly. Ask your students to guess what would happen if they started with two *E. coli* bacteria. How many bacteria do they think would be present at the end of four hours?
2. Then show them the film at [www.cellsalive.com/ecoli.htm](http://www.cellsalive.com/ecoli.htm).

*Exploration* (20 minutes)

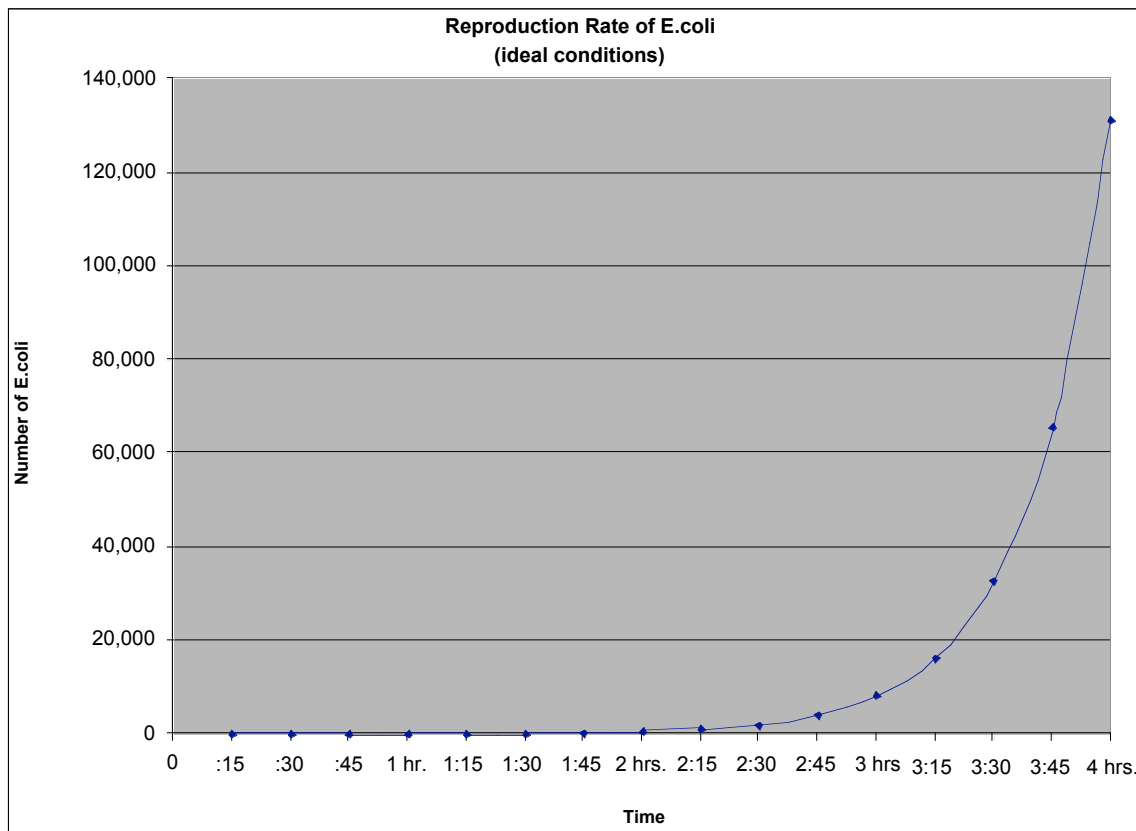
1. Now tell students that they are going to find out for themselves how many bacteria can exist by the end of four hours.

- Hand out Student Reproducible 1: *Microbe Multiplication Magic*. Have students do the analysis. Assume they start with two *E. coli* bacteria, and that the bacteria reproduce (split into two separate bacteria) every 15 minutes. Have them fill in the numbers under the “Ideal Conditions” chart.

| Minutes                  | :15 | :30 | :45 | 1 hr. | 1:15 | 1:30 | 1:45 | 2 hrs. |
|--------------------------|-----|-----|-----|-------|------|------|------|--------|
| Number of <i>E. coli</i> | 4   | 8   | 16  | 32    | 64   | 128  | 256  | 512    |

| 2:15  | 2:30  | 2:45  | 3 hrs. | 3:15   | 3:30   | 3:45   | 4 hrs.  |
|-------|-------|-------|--------|--------|--------|--------|---------|
| 1,024 | 2,048 | 4,096 | 8,192  | 16,384 | 32,768 | 65,536 | 131,072 |

- Check to see whether your students have calculated correctly the total number of bacteria that would be available under ideal conditions. How many bacteria will be present at the end of one hour (answer:32)? At the end of four hours (answer: 131,072)?
- Once students have done the calculations, have them create a graph showing their findings. Put the time on the horizontal line. Put the number of *E. coli* bacteria on the vertical line.
- Your students’ graph should look like this.



*Explanation* (5 minutes)

1. Discuss with students: Why isn't the world covered with bacteria? Ask students to speculate a bit. Write their answers on the board.

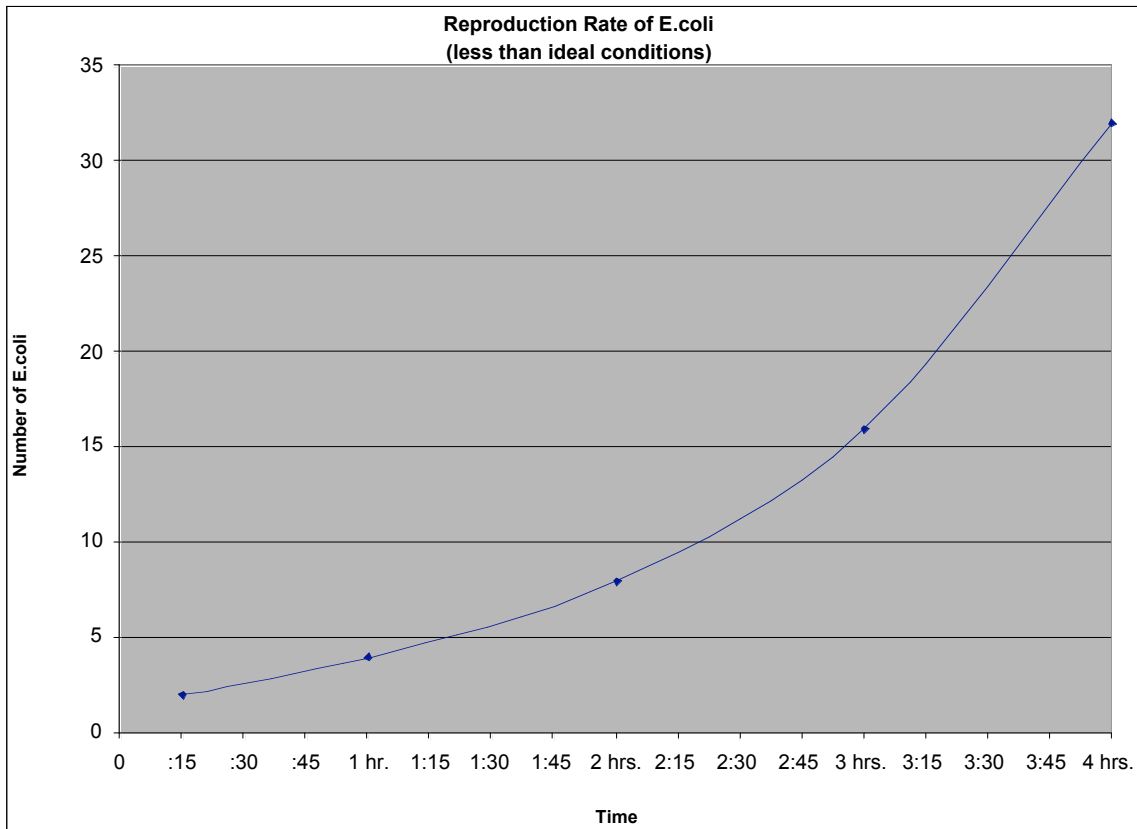
The answer is that conditions in the real world are rarely as ideal as they are in a lab. Scientists who study bacteria try to create an environment in which bacteria can thrive—with the right nutrients, temperature, and so on.

*Elaboration* (10 minutes)

1. Now tell students that they will simulate conditions that are less than ideal. Assuming that instead of reproducing every 15 minutes, a drop in temperature meant that the bacteria reproduced only every 60 minutes. Again, have them complete the chart, this time filling in numbers in the "Less Than Ideal" chart. In this case, how many bacteria would there be in 1 hour (answer: 4)? How many would there be in 4 hours (answer: 32)?

| Minutes                  | :15 | :30 | :45 | 1 hr. | 1:15 | 1:30 | 1 :45 | 2 hrs. |
|--------------------------|-----|-----|-----|-------|------|------|-------|--------|
| Number of <i>E. coli</i> | 2   |     |     | 4     |      |      |       | 8      |

| 2:15 | 2:30 | 2:45 | 3 hrs. | 3:15 | 3:30 | 3:45 | 4 hrs. |
|------|------|------|--------|------|------|------|--------|
|      |      |      | 16     |      |      |      | 32     |



There is a formula that can help students determine the number of bacteria over time. Your students can find the formula, along with a clear explanation, at <http://mathforum.org/library/drmath/view/58230.html>

2. Discuss with students how this activity demonstrates the role of the environment in the spread of disease.

*Evaluation (5 minutes)*

### **Performance Descriptors**

| <b>Microbe Multiplication Magic</b> |   |
|-------------------------------------|---|
| <b>Rating</b>                       | <b>Performance Descriptor</b>   |
| <b>4</b>                            | <p>Students have done the calculations correctly for both the chart showing growth rate under ideal conditions and the chart showing growth rate under less than ideal conditions. Students have correctly created graphs to show their findings.</p> <p>Students clearly explain the role of the environment in the spread of disease.</p>               |
| <b>3</b>                            | <p>Students have done the calculations for both the chart showing growth rate under ideal conditions and the chart showing growth rate under less than ideal conditions. There may be one minor computation error. Students have created graphs to show their findings.</p> <p>Students explain the role of the environment in the spread of disease.</p> |
| <b>2</b>                            | <p>Students have made an effort to do both sets of calculations, but have incomplete or incorrect numbers. Students have made an effort to create graphs, but may not have been able to complete them.</p> <p>Students partially explain the role of the environment in the spread of disease.</p>  |
| <b>1</b>                            | <p>Students have done minimal work in doing the calculations and may not have made an effort to create graphs.</p> <p>Students cannot explain the role of the environment in the spread of disease.</p>   |

*Extension*

1. Students can explore the *Immune Platoon* on the *BAM!* Web site at [www.bam.gov/sub\\_diseases/diseases\\_immuneplatoon.html](http://www.bam.gov/sub_diseases/diseases_immuneplatoon.html) for more information on infectious diseases and how the body fights them.

### **Text Correlations**

Glencoe, *Teen Health, Level 1*, Chapter 12: Understanding Communicable Diseases

Glencoe, *Teen Health, Level 2*, Chapter 7: Preventing Diseases

Glencoe, *Teen Health, Level 3*, Chapter 17: Communicable Diseases

### **Web Resources**

CDC *BAM! Body and Mind*<sup>TM</sup>: [www.cdc.gov/bam](http://www.cdc.gov/bam) or [www.bam.gov](http://www.bam.gov)

*BAM! Body and Mind* is brought to you by the Centers for Disease Control and Prevention (CDC), an agency of the U.S. Department of Health and Human Services (DHHS). *BAM!* was created to answer kids' questions on health issues and recommend ways to make their bodies and minds healthier, stronger, and safer. *BAM!* also serves as an aid to teachers, providing them with interactive activities to support their health and science curriculums that are educational and fun.

Centers for Disease Control and Prevention (CDC): [www.cdc.gov](http://www.cdc.gov)

The CDC Web site provides a comprehensive overview of the latest research on infectious diseases. From research studies on infectious diseases to information for travelers, this site provides a wealth of information. Some is written for medical professionals, but much of the information is written for health care consumers.

### **Relevant Standards**

#### *Benchmarks for Science Literacy*

##### Chapter 5, Benchmark C, Grades 3-5: Cells

By the end of grade 5, students should know that:

- Some living things consist of a single cell. Like familiar organisms, they need food, water, and air; a way to dispose of waste; and an environment they can live in.

##### Chapter 5, Benchmark C, Grades 6-8: Cells

By the end of grade 8, students should know that:

- Cells repeatedly divide to make more cells for growth and repair. Various organs and tissues function to serve the needs of cells for food, air, and waste removal.

**Lesson 4, Activity 3, Student Reproducible 1:**

***Microbe Multiplication Magic***

**Ideal Conditions**

Assume that you begin with 2 *E. coli* bacteria and they reproduce (split into two separate bacteria) every 15 minutes.

| Minutes                     | 15 | 30 | 45 | 1 hr. | 1:15 | 1:30 | 1 :45 | 2 hrs. |
|-----------------------------|----|----|----|-------|------|------|-------|--------|
| Number of<br><i>E. coli</i> |    |    |    |       |      |      |       |        |

| 2:15 | 2:30 | 2:45 | 3 hrs. | 3:15 | 3:30 | 3:45 | 4 hrs. |
|------|------|------|--------|------|------|------|--------|
|      |      |      |        |      |      |      |        |

Create a graph showing your findings here:

**Less than Ideal Conditions**

Assume that you begin with 2 *E. coli* bacteria and they reproduce (split into two separate bacteria) every hour.

| Minutes                     | 15 | 30 | 45 | 1 hr. | 1:15 | 1:30 | 1 :45 | 2 hrs. |
|-----------------------------|----|----|----|-------|------|------|-------|--------|
| Number of<br><i>E. coli</i> |    |    |    |       |      |      |       |        |

| 2:15 | 2:30 | 2:45 | 3 hrs. | 3:15 | 3:30 | 3:45 | 4 hrs. |
|------|------|------|--------|------|------|------|--------|
|      |      |      |        |      |      |      |        |

Create a graph showing your findings here: